Electronic Version
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Claims

[c1] An x-ray anode comprising:
a substrate material;
a target material; and
one or more graded CTE material layers coupling the substrate material to the target material.

[c2] The x-ray anode of claim 1 wherein the substrate material is a lightweight material.

[c3] The x-ray anode of claim 1 wherein the substrate material is a carbon-fiber material.

[c4] The x-ray anode of claim 1 wherein the target material is a refractory metal.

[c5] The x-ray anode of claim 1 wherein the target material is a tungsten alloy.

[c6] The x-ray anode of claim 1 wherein the target material is a molybdenum alloy.

[c7] The x-ray anode of claim 1 wherein each of the one or more graded CTE material layers is layered sequentially from the substrate material.

[c8] The x-ray anode of claim 7 wherein each of the one or more graded CTE material layers is layered horizontally from the substrate surface.

[c9] The x-ray anode of claim 1 wherein each of the one or more graded CTE material layers has an approximate coefficient of thermal expansion averaging between each of the adjacent materials.

[c10] The x-ray anode of claim 1 wherein each of the one or more graded CTE material layers has a differing coefficient of thermal expansion.

[c11] The x-ray anode of claim 10 wherein the differing coefficient of thermal expansion of $2x10^{-6}/^{o}C$.

[c12] The x-ray anode of claim 10 wherein the differing coefficient of thermal expansion of $1x10^{-6}/^{o}C$.

[c13] The x-ray anode of claim 10 wherein the differing coefficient of thermal expansion less than $1\ x10^{-6}/^{o}C$.

[c14] The x-ray anode of claim 1 wherein each of the one or more graded CTE material layers comprises tungsten, tungsten borides, tungsten carbides, molybdenum, molybdenum borides, molybdenum carbides, hafnium, hafnium carbides, or binders, together with chopped carbon fiber, wherein varying the coefficient of thermal

expansion may be achieved by altering the proportions of the carbon fiber material.

[c15] The x-ray anode of claim 14 wherein the carbon fiber is chopped pitch fibers.

[c16] The x-ray anode of claim 1 wherein the x-ray anode is a rotating x-ray anode.

[c17] A method of making an x-ray anode comprising:
providing a substrate having a target location;
coating the target location of the substrate with a slurry mixture to form one or more graded CTE material layers;
drying the coating;
depositing a target material on the last of the one or more graded CTE material layers; and
heating to bond the target material, the material layers and the substrate material.

[c18] The method of claim 16 wherein the substrate is made from woven carbon fibers, the graded CTE material layers comprise W, W2B, WC, chopped carbon fibers, and binders, drying is at sintering temperature, the target material is 95% W and 5% Re, and bonding by heating to 2350^{O} C.

[c19] The method of claim 16 wherein coating comprises applying each of the one or more graded CTE material lay-

ers having different CTE in each layer determined by the percentage of carbon in the slurry mixture.

[c20] The method of claim 16 wherein the slurry mixture for each graded layer comprises a different amount of chopped carbon fibers.

[c21] A method of making an x-ray anode comprising:
providing a substrate having a target location;
coating the target location of the substrate with a slurry mixture to form one or more graded CTE material layers;
sintering the coating;
depositing a target material on the last of the one or more graded CTE material layers; and
heating to bond the target material, the material layers and the substrate material.

[c22] The method of claim 20 wherein the substrate is made from woven carbon fibers, the graded CTE material layers comprise W, W2B, HfC, Hf, chopped carbon fibers, and binders, sintering is at 1865^{O} C, the target material is 95% W and 5% Re, and bonding by heating to 1865^{O} C.

[c23] The method of claim 20 wherein coating comprises applying each of the one or more graded CTE material layers having different CTE in each layer determined by the percentage of carbon in the slurry mixture.

[c24] The method of claim 20 wherein the slurry mixture for each graded layer comprises a different amount of chopped carbon fibers.